

Conceptual Design of an Oxygen Diffuser System to Reduce Anoxic Products in Reservoir Releases

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Introduction

This abstract is a summary of the diffuser design portions of a study conducted by the authors for the Nashville District of the US Army Corps of Engineers for J. Percy Priest Dam and reservoir. Design goals for the diffuser system included increasing tailwater DO levels and reducing anoxic products such as hydrogen sulfide.

Diffuser Design Requirements

Unlike previous porous hose diffuser applications, the high oxygen demands, mid-level intakes, and long periods of no turbine operation at J. Percy Priest require a significant departure from a straightforward hydropower oxygenation design. The conditions at J. Percy Priest require an oxygenation system that is capable of meeting the oxygen demands of high water flow rates during consecutive days of turbine operation, as well as maintaining oxygenated forebay conditions during long periods of no turbine operation. In addition, the system must distribute the oxygen well upstream of the dam to obtain the retention times necessary to impact the anoxic products in the reservoir. The conceptual design of the oxygenation system in this presentation is the result of the application of the expertise obtained designing, installing and operating eleven line diffuser systems for TVA and other utilities.

Diffuser Design to Meet Objectives

To meet these objectives, the design team took advantage of the inherent flexibility of the porous hose line diffuser to place oxygen at specific locations spread throughout the J. Percy Priest forebay to meet specific oxygen demands identified by the team. The diffusers are designed to serve dual purposes by being operated to meet different oxygen demand rates depending on turbine operation. During turbine operation, oxygen input is

spread over the elevations of the turbine withdrawal zone up to 5,000 feet upstream of the dam. An oxygen input of 37 tons per day is required to increase the 4,600 cfs turbine flow from 2 to 5 mg/L. However, just achieving 5 mg/L is not sufficient to avoid an immediate DO decrease in the tailwater due to oxygen demands still active in the turbine release. Therefore, additional diffusers are located in the old riverbed and at higher elevations to satisfy the maximum BOD expected for the incoming water from the non-oxygenated portions of the reservoir. During periods of no turbine operation, three of these same diffusers would be operated at reduced oxygen flow rates to place oxygen in strategic elevations of the forebay and directly in front of the turbines to maintain an oxygenated volume for initial turbine operations. Longer periods of no turbine operation will afford these diffusers the retention time necessary to oxidize more anoxic products in the forebay.

In this conceptual study, the line diffuser system is supplied by a liquid oxygen storage facility. The oxygen facility was designed with 80 tons per day of delivery capacity and would be located on the J. Percy Priest Reservation near an existing boat ramp. The use of liquid oxygen is the preferred method for supplying J. Percy Priest because liquid oxygen deliveries are readily available and the facility is economical, highly reliable and simple to adjust and operate.